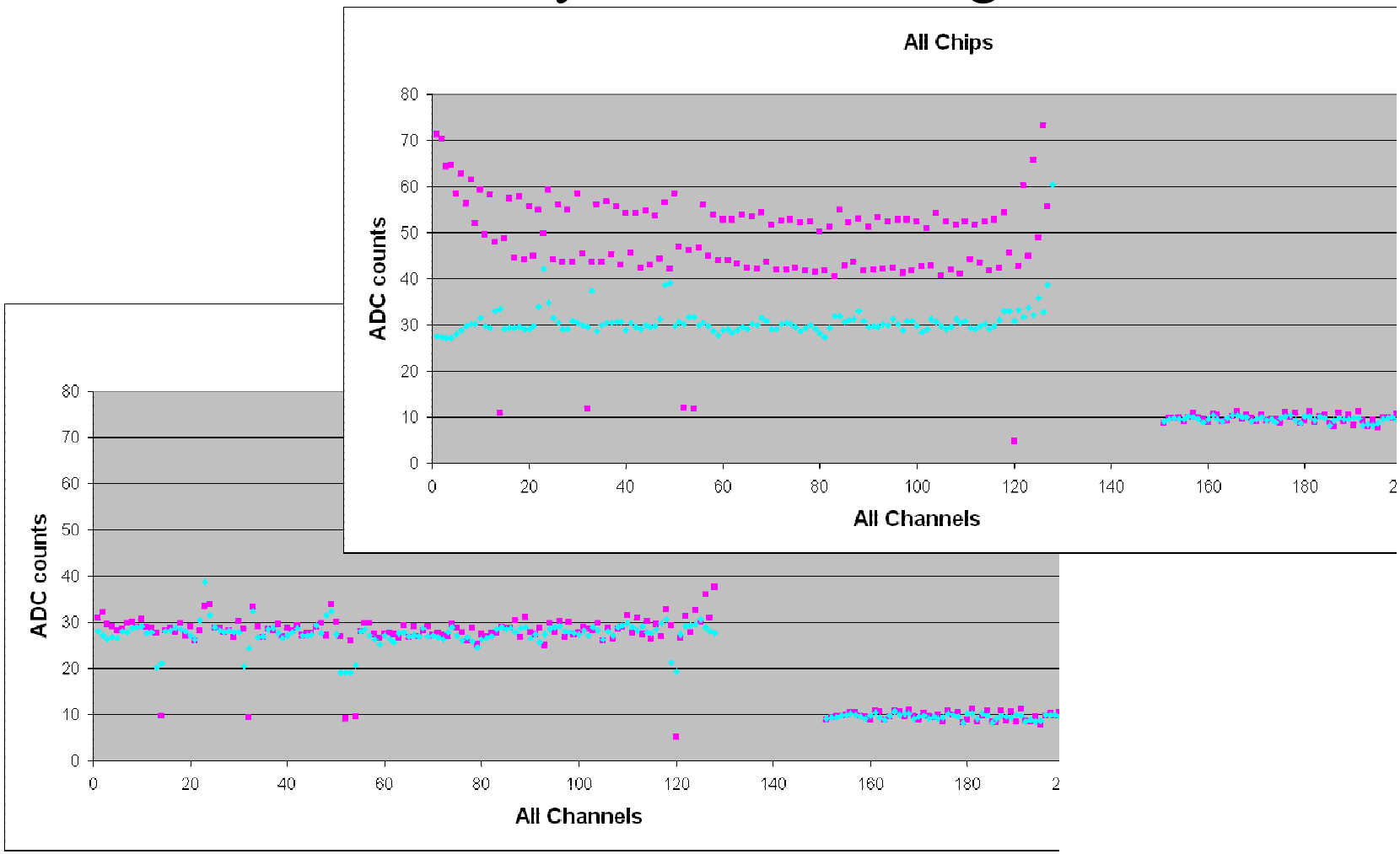
Analog Cable Status

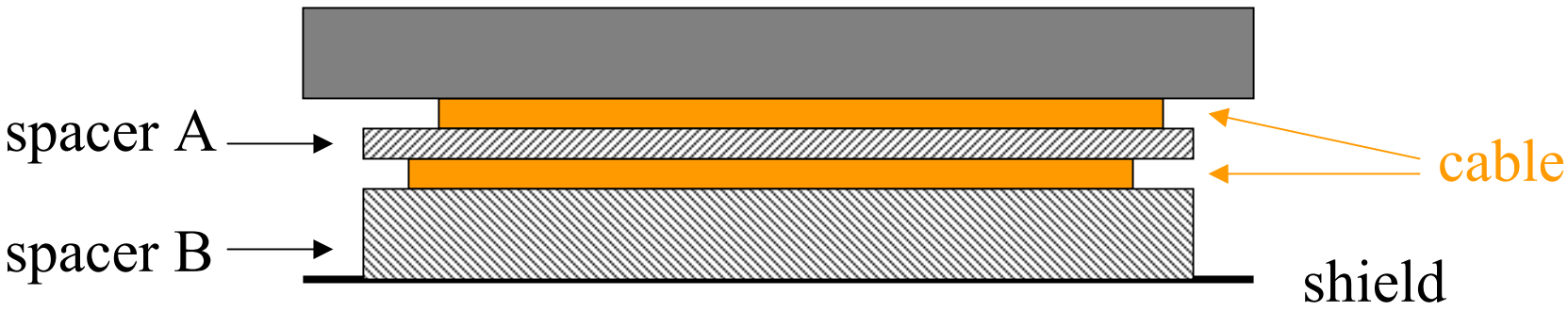
- Basic design fixed --- the latest cable has good quality. (report by Frank)
- Capacitance for single cable ~0.35pF/cm --- both new and old cable OK.
- The remaining unknown are;
  - Laminated or not.
  - Spacer material and its thickness.

Proximity to the Shielding



- Only the difference is the weight on top of the cables.
  ➔ Proximity to the shielding material.

Proximity to the Shielding (cont'd)



- Spacer: 75μm thick Kapton and/or 200μm thick polypropylene mesh sheet.

Proximity to the Shielding (cont'd -2)

- Unit is in ADC counts (1ADC ~ 700 e)

Table 1: The noise level in unit of ADC counts. Two cables stacked together. Underneath the cables is the grounding/sheilding copper G10. Kap. denotes Kapton, and PP denotes polypropylene.

space btwn two cables	space btwn btm cable and shielding	top	bottom
no weight	no weight	2.8	2.8
none	525μm Kap.	3.0	3.0
none	300μm Kap.	3.3	3.7
225μm Kap.	300μm Kap.	3.2	3.6
none	75μm Kap.	4.3	5.3
none	75μm Kap. and 400μm PP mesh	2.8	2.9
225μm Kap.	75μm Kap. and 400μm PP mesh	2.8	2.8
none	75μm Kap. and 200μm PP mesh	3.2	3.3

- The error ~ 0.1 or 0.2 ADC counts. (my eye ball scan)

Laminated or not?

- Capacitance for laminated cables: 0.51pF/cm (by Frank)
- ANSYS calculation: 0.47pF/cm for the dielectric of 2.5 for the spacer.
- Noise measurement with the non-laminated cables.

- Noise level does not affected by the spacer between the two cables. ← contradictory with the capacitance measurement and ANSYS calculation.
  ← This may be explained by the fact that there is still air gaps between the non-laminated cables. Or additional capacitive coupling introduced by the lamination?
- This must be clarified by building new prototype module with laminated cable.
- Bonding issue must be also addressed.

Spacer

- Candidates: Kapton mesh and polypropylene mesh.
- For non-laminated cable, 200μm is good enough for between each cable. May be possible to reduce.
- Between cable and shielding material, 400μm may need for polypropylene mesh, hopeless for normal Kapton, and needs to be tested for Kapton mesh.
  ➔ Need tests with Kapton mesh.

Radiation length

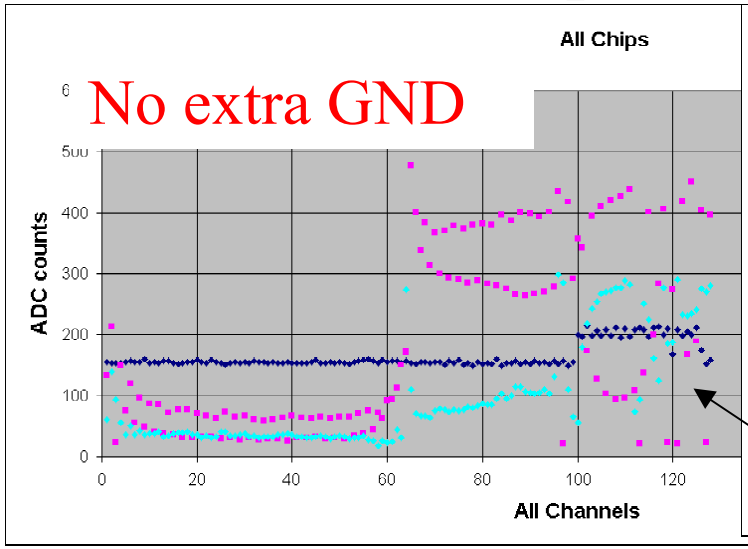
Min (2 cables)		Max (12 cables)	
100μm Kapton	0.04%	600μm Kapton	0.21%
3μm Cu (a)	0.02%	16μm Cu (a)	0.11%
300μm (b) polypropylene	0.07%	1300μm (b) polypropylene	0.32%
20μm Al (c)	0.02%	20μm Al (c)	0.02%
Total	0.15%	Total	0.66%

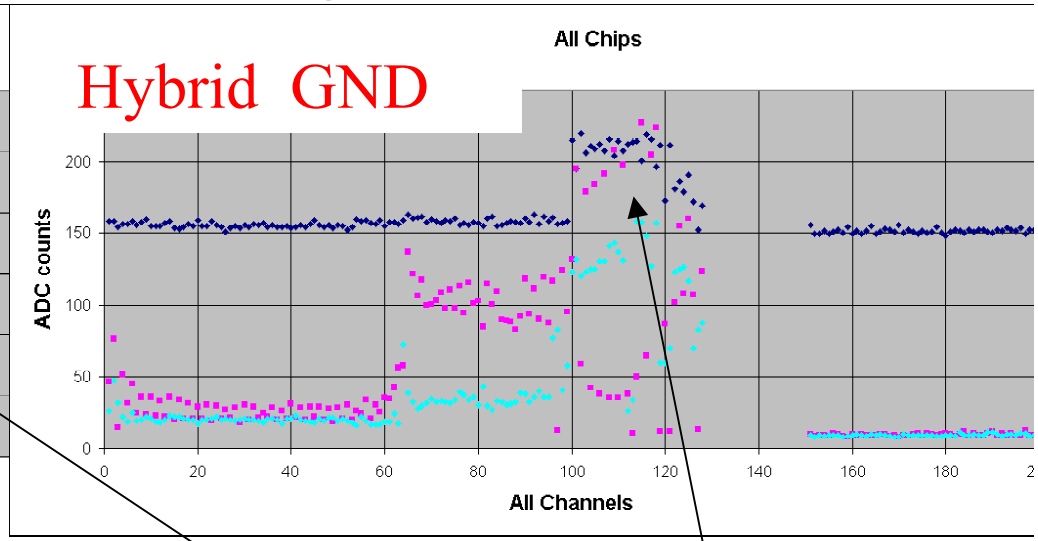
- 200μm thick polypropylene mesh for each layer.
- (a) 16% of area occupancy is taken account.
- (b) 50% of volume occupancy assumed. May be possible to reduce.
- (c) heavy duty aluminum foil was measured to be 20μm thick.

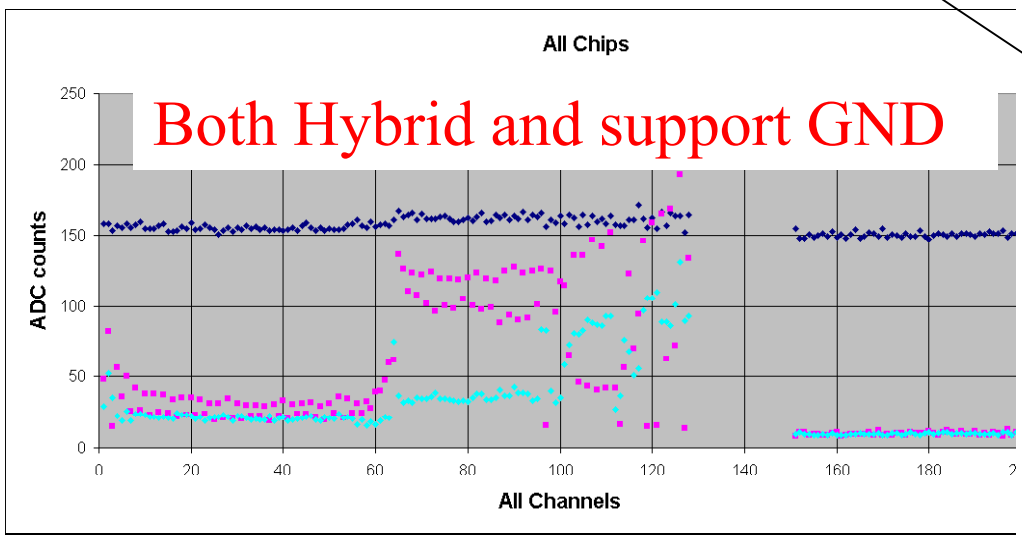
L0 grounding issues

- We should decide:
  - ➢ Ground at hybrid only, or ground both at hybrid and sensor?
    - ← Resistance (HV/GND trace) of analog cable ~ 10 to 20 Ω.
  - ➢ Is shielding metal connected to hybrid GND or sensor GND?
  - ➢ The actual mechanical way of connection.
    - ❑ Hybrid support to GND
    - ❑ L0 support to GND

Example of Grounding Effect







Note: cal_inject only for two top plots.

- Module on the structure w/o any shielding. (support structure grounded through analog cable.)